The Afghanistan Engineering Support Program assembled this deliverable. It is an approved, official USAID document. Budget information contained herein is for illustrative purposes. All policy, personal, financial, and procurement sensitive information has been removed. Additional information on the report can be obtained from Firouz Rooyani, Tetra Tech Sr. VP International Operations, (703) 387-2151.

TETRA TECH

MEMORANDUM

To: [redacted], USAID-OIEE

From: [redacted], Tetra Tech
[redacted], Tetra Tech Technical Lead
[redacted], Tetra Tech Technical Support Manager

Date: October 1, 2011

Re: **AESP WO-A-0078 Kajaki Unit 2 Assessment**

Introduction

This technical memorandum presents an evaluation of the proposed plan for installation of the Unit 2 components in to the existing power house. Units 1 and 3 were installed in the 1970's. The Unit 2 components were fabricated by China's CMIC and delivered to the site in 2008. Tetra Tech staff visited the site in 2010 to evaluate the existing conditions. Black & Veatch (B&V) staff visited the site for two (2) extended periods in 2011 to document and assess the condition of the site and the Unit 2 components that are stored there.

Proposed Construction

The project consists of refurbishing, repairing or replacement of Unit 2 components and then installing the turbine, generator and associated equipment and controls in the center bay of the existing four (4) level powerhouse.

Construction would start with the setup of work facilities immediately followed by the refurbishing of turbine components. Simultaneously, the foundation and concrete work for the turbine unit in the powerhouse would be constructed. This is dependent on sourcing the aggregate and Portland cement needed to produce concrete on site.

Once the components for the penstock and tailrace are ready, they will be placed in the powerhouse, followed by the placement of the main turbine section. Once the main turbine section is complete, the switch gear and SCADA would be installed. Additionally, the turbine maintenance hardware, such as the oil system, cooling system and station power controls, would also be installed. Finally, the individual components would be tested prior to commissioning of the system.

Site Conditions

The site is located 100 km by road from Kandahar, Afghanistan. The site is secured by Afghan and NATO forces. Additional private contractor security forces would be required to ensure safe working conditions. Due to the remote location of the site, a self-contained construction operation is required. The existing onsite LSA would be upgraded and placed into operation for the engineering and construction teams.

Engineering Recommendations

The basic components to install turbine #2 are on site at the powerhouse laydown yard in various states of condition. The use of these components will require some level of restoration or replacement. The list of components that require replacement will not be known until an attempt at refurbishing is done. In addition, there may be some design flaws and other issues that will need to be addressed as work progresses.

Construction Considerations

Due to the location of the site and the hazards involved, the ability to import materials and manpower is difficult. This will cause some delays in construction. Significant preplanning will need to be done to ensure that the construction operation is self-contained and will minimize the need for outside resources.

All of the site materials will be delivered to the project at the start of work. The CMIC components will be refurbished or replaced as needed. In order to allow some lead time for any necessary replacement items, much of this work can be done well in advance of component installations.

The data from B&V indicates that most of the turbine components are usable with some preparatory work. During the time interval between the B&V study of the components and the beginning of construction, the materials may suffer further deterioration.

On site equipment will be restored for use by the contractor. Some time may be needed to make the equipment repairs.

The contractor will provide an onsite batch plant and source aggregate resources near the dam. Access to these resources is assumed to be provided by the government.

Implementation Schedule

Upon notice to proceed, efforts would be made to review construction drawings, procure needed materials and establish the construction camp on site. This will

include the bidding process to secure subcontractors for the security services, life support area, turbine components restoration and installation of turbine #2. This process should require approximately 6 months.

Actual field work should require approximately 18 months for completion barring any changes in the security of the area and ability to use the CMIC components. Additional time may be required if major components are found to be unusable.

While materials are purchased, a subcontractor team would be secured. The LSA would be set up and operational ASAP. A schematic layout of an LSA we use in southern Afghanistan is shown in Figure 1. Once the contractor mobilizes to the site, refurbishing of turbine components would begin. The onsite batch plant and aggregate sources would be set up so concrete work can begin.

Upon completion of the foundation work, the inlet and outlet structures can be installed. Then the turbine unit followed by the generator can be placed.

Testing of each major assembly will be done as work proceeds. This way, if needed, components can be removed for correction without major work.

Once the turbine/generator combination is in place, the SCADA, switchgear and support equipment can be installed and tested.

Prior to commissioning, each major system would be tested.

Should a delay be caused due to the need to import any components, the schedule would be reviewed to determine what other work activities could be substituted to assist with maintaining the completion date.

Procurement Strategy

Many of the materials already on site will require some repair or replacement. This may require some custom parts fabrication rather than off the shelf procurement. When the timeline for such a component is unreasonable, total replacement of the unit may be required. As such, upon NTP, the refurbishment process would commence as soon as possible to allow the greatest lead time in the event new components are required.

The government's detailed list of components would be used along with the construction specifications and drawings to determine the list of materials required. Once this list is compared to the onsite inventory, all needed items would be purchased and rapid delivery to the site established.

TETRA TECH

B&V Report Comments

Tetra Tech has reviewed the report titled "Kajaki Dam Unit 2 Hydro Inventory and Condition Assessment Report – Draft Final" dated August 28, 2011 prepared by Black & Veatch.

1. The assessment appears to be a thorough and fair evaluation of the situation in the field. We reviewed the recommendations, with particular interest in the items recommended for replacement, and have the following comments:
   a. Numerous flanges are identified as needing to be replaced. Some basic machine shop tools will be required, and these tools can be used to repair rusted or slightly damaged flanges instead of replacing them.
   b. Reference 16 under Section 4.3.5 states that 150 stator bars need replacement under the "Recommendation", but under "Replace" it indicates the number is 128 due to moisture contamination.
   c. The 8 air coolers may not need to be replaced if all that is needed is some rust removal on the flanges.
   d. Additional consideration should be given to full replacement of the 13.8 kV switchgear, such as installing a safety wall.

2. A water purification plant to filter river water may be less expensive than importing bottled water. Alternatively, a shallow well with chlorination may also be a less expensive option.

3. A camp for 170 workers is excessive. The maximum number of workers, excluding local labor, at any given time may not exceed 100.

4. Fuel quantity and cost for powering the camp (page 91) may be excessive. If the camp can utilize power generated from project when it is in service, and the camp size is reduced, perhaps a significant reduction of this cost can be realized. It appears they assumed an average continuous load of 375 KW for 3 years.

5. It is hard to see a strong correlation between the Kajaki Unit 2 estimated costs and the two projects listed for comparison in Section 10 of the report. The Lower Baker Project consists of a new concrete powerhouse housing a single 30-MW unit and an approximate 800-foot long, 12-foot diameter, lined tunnel. The Snettisham Project also involves a long tunnel and penstock, and is much different than the work contemplated at Kajaki.

6. Care should be taken with drawing strong conclusions from the cost comparison with Department of Energy data. The DOE data is based generally on the cost of major features such as dams, water conveyance

facilities, and a powerhouse. Other than some structural work inside of an existing powerhouse, the Kajaki Project does not involve these facilities. Despite not constructing a dam, penstock, new powerhouse, nor purchasing a new turbine/generator unit, the adjusted capital cost for Kajaki is still higher than the "high-end range" of DOE costs. The adjusted cost for Kajaki Unit 2 work would be expected to fall at or below the DOE "low-end range".

7. The schedule calls for all 3 units to be installed and on-line by October 2014. This appears to be a somewhat relaxed schedule and requires a full 4-month outage during a portion of the Spring runoff period. The procurement period of 12 months seems excessive, and the most critical long-lead items can be ordered well before August 2012. Installation time for the Unit 2 turbine also appears excessive. With some critical thinking, it is quite possible to cut 10-12 months off the schedule, assuming unplanned delays due to security issues are not considered. This project needs to be scheduled with a better eye toward compressing the critical path similar to what one would do for a U.S. utility where time is money, and in this instance it could also mean less risk to personal safety.

Estimated Program Costs

The following estimates are based on information and data provided by Black & Veatch. The PM and Engineering costs assumes two (2) reach back teams in the United States providing Design Engineering and Construction Services, respectively. The team in Afghanistan consists of a group of expatriate engineers with a support team of local/regional staff. Approximately 23 man-years of time are estimated to complete the project within 18 months.

In addition to PM and Engineering services, a cost estimate has been derived for the construction of the project, including Contractor and Sub costs. Several assumptions were made in the analysis, including:

- Inspections and assumptions by B&V are accurate.
- The majority of the CMIC components that have been left onsite are usable or may be reconditioned.
- All plans, specifications and other information for the original design and installation of turbine #2 will be provided by the government.
- The building facility that houses the turbines is in an "operable" condition to complete the work.
- The security situation remains consistent throughout the duration of the project.

Table 1 is a summary of the Rough Order of Magnitude (ROM) to complete the Turbine #2 installation. A review of all data and field conditions would be required to further verify the analysis. Detailed cost items are shown on the attached spreadsheets.

Table 1: Turbine #2 Rough Order of Magnitude (ROM) Cost Estimate

PM and Engineering	Man-yrs	Cost
Expatriate Onsite Direct Labor	12	[redacted]
Other Onsite Direct Labor	4	
PMO Design Team (US based)	5	
PMO Construction Team (US based)	1	
Other Direct Costs	---	
DBA Costs	---	
Tax	---	
Contingency	---	
Subtotal	**23**	

Contractor and Subs	Duration (months)	Cost
General Conditions	18	[redacted]
Recondition Components	6	
Security	18	
Life Support Areas (LSA)	18	
Batch Plant/Concrete Work	6	
Turbine Installation	12	
Contingency	---	
Profit	---	
Subtotal		

Turbine # 2 Subtotal	[redacted]
GL and BR Insurance @ 0.8%	
Turbine #2 Total	

Note: Cost Estimate prepared September 21, 2001.

Limitations

As previously mentioned, the recommendations in this report are based upon information and data collected and provided by others. Actual costs will be based on a detailed audit of actual field conditions and changes in the work environment.

Kajaki Dam, Turbine Unit #2
Helmand Province, Afghanistan
USAID - Afghanistan Engineering Support Program (AESP)
Rough Order of Magnitude Estimate - Contractor & Subs

Bid Item	Description	Quantity	Units	Unit Price	Bid Total
	General Conditions				
110	Site Management and Administration	18	MO	[redacted]	$ [redacted]
120	Survey & Field Engineering	18	MO		$
130	Contractor Quality Control & QCIP	18	MO		$
140	Contractor Mobilization	1	LS		$
	Sub-Total: General Conditions				$
	Recondition components				
210	Runner-mate to shaft. Check to see correct fit.	1	LS		$
220	Replace head cover bolts	1	LS		$
230	Restore Wicket gate bushings and lube	1	LS		$
240	field test governor oil tank	1	LS		$
250	main inlet valve. Repaint and lube	1	LS		$
260	Draft tube. Clean and repaint	1	LS		$
270	Draft tube-16' section to tail race. Steel line.	1	LS		$
280	Band- stamp in guide markings	1	LS		$
290	Spiral Case sections	1	LS		$
300	Inside of turbine	1	LS		$
310	Operation Ring - replace pad, buff and paint	1	LS		$
320	Unit 1 and 3 governors	1	LS		$
330	PLC provided for all three turbines	1	LS		$
340	Governor air reciever	1	LS		$
350	Control Cabinet	1	LS		$
360	Inlet valve- address under item 250	1	LS		$
370	motor and valve	1	LS		$
380	seals	1	LS		$
390	Flanged section	1	LS		$
400	Flanged section	1	LS		$
410	Piping	1	LS		$
420	Lube Oil	1	LS		$
430	Oil Storage	1	LS		$
440	Fittings	1	LS		$
450	Flanges	1	LS		$
460	Flanges	1	LS		$
470	Flanges	1	LS		$
480	Clean the windings	1	LS		$
490	Re wedge the stator	1	LS		$
500	Testing	1	LS		$
510	Stator bars	1	LS		$
520	Air Coolers	1	LS		$
530	Insulating hardware tightened	1	LS		$
540	Bus sections	1	LS		$
550	Paint materials	1	LS		$
560	field poles	1	LS		$
570	Thrust bearing runner-rotating plate	1	LS		$
580	Thrust bearing insulation	1	LS		$
590	Collector Ring	1	LS		$
600	Excitation System	1	LS		$
610	Generator Neutral Cubicle	1	LS		$
620	Switchgear	1	LS		$
630	Bus Duct	1	LS		$
640	Transformers	1	LS		$
650	Transformer testing	1	LS		$
660	sample atmosphere in Transformers	1	LS		$
670	Control panels	1	LS		$
680	SCADA	1	LS		$
690	Cable termintation kits	1	LS		$
700	Cable termintation kits	1	LS		$
710	Self cleaning water strainers	1	LS		$
720	20 12v batteries	1	LS		$

730	Station Service Modifications	1	LS	$
740	Misc. Loose parts-O-rings, seals, bolts	1	LS	$
750	Elect. Cable	1	LS	$
760	Detail Inventory of small items	1	LS	$
770	Building upgrades	1	LS	$
780	crane repair	1	LS	$
781	Shipping budget	1	LS	$
782	Site consumables- hyd. Oil, oiler system	1	LS	$
783	Restoration shop supplies	1	LS	$
	Sub-Total: Recondition Components			**$**

Security

790	Security force	18	Months	$
	Sub-Total: Security			**$**

LSA-Life Support Area

810	Initial set up	1	LS	$
820	Monthly cost	18	m	$
830	On site vehicles	2	each	$
840	maint. And fuel for vehicles	1	LS	$
	Sub-Total: LSA			**$**

Batch Plant

520	concrete placed at plant for turbine	1,100	CY	$
	Sub-Total: Batch Plant			**$**

Install turbine #2

540	Install turbine	1	LS	$
	Sub-total: Install Turbine #2			**$**

Project Subtotal		
Project Contingincies	*20%*	
Sub total		
Profit	*5.5%*	
TOTAL		

Kajaki Dam, Turbine Unit #2
Helmand Province, Afghanistan
USAID - Afghanistan Engineering Support Program (AESP)
Rough Order of Magnitude Estimate - PM & Engineering

Assumed Time (Months)	18
Assumed Work Week (Hours)	72

Reachback Direct Labor:	**Raw Labor Rate/Hr**	**Overhead (124.41%)**	**G&A (17.61%)**	**Fee (7%)**	**Adjusted Hr. Rate**	**Hours**	**Sub total**
PMO - Design Services	---	---	---	---	---	---	[redacted]
Vice President	[redacted]						
Project Manager							
Mechanical Engineer - Senior							
Mechanical Engineer - Mid-Level							
Electrical Engineer - Senior							
Electrical Engineer - Mid-Level							
Civil Engineer - Mid - Level							
Instrumentation Engineer - Senior							
Instrumentation Engineer - Mid-Level							
CAD Drafter 1							
CAD Drafter 2							
Subtotal: PMO - Design Services							

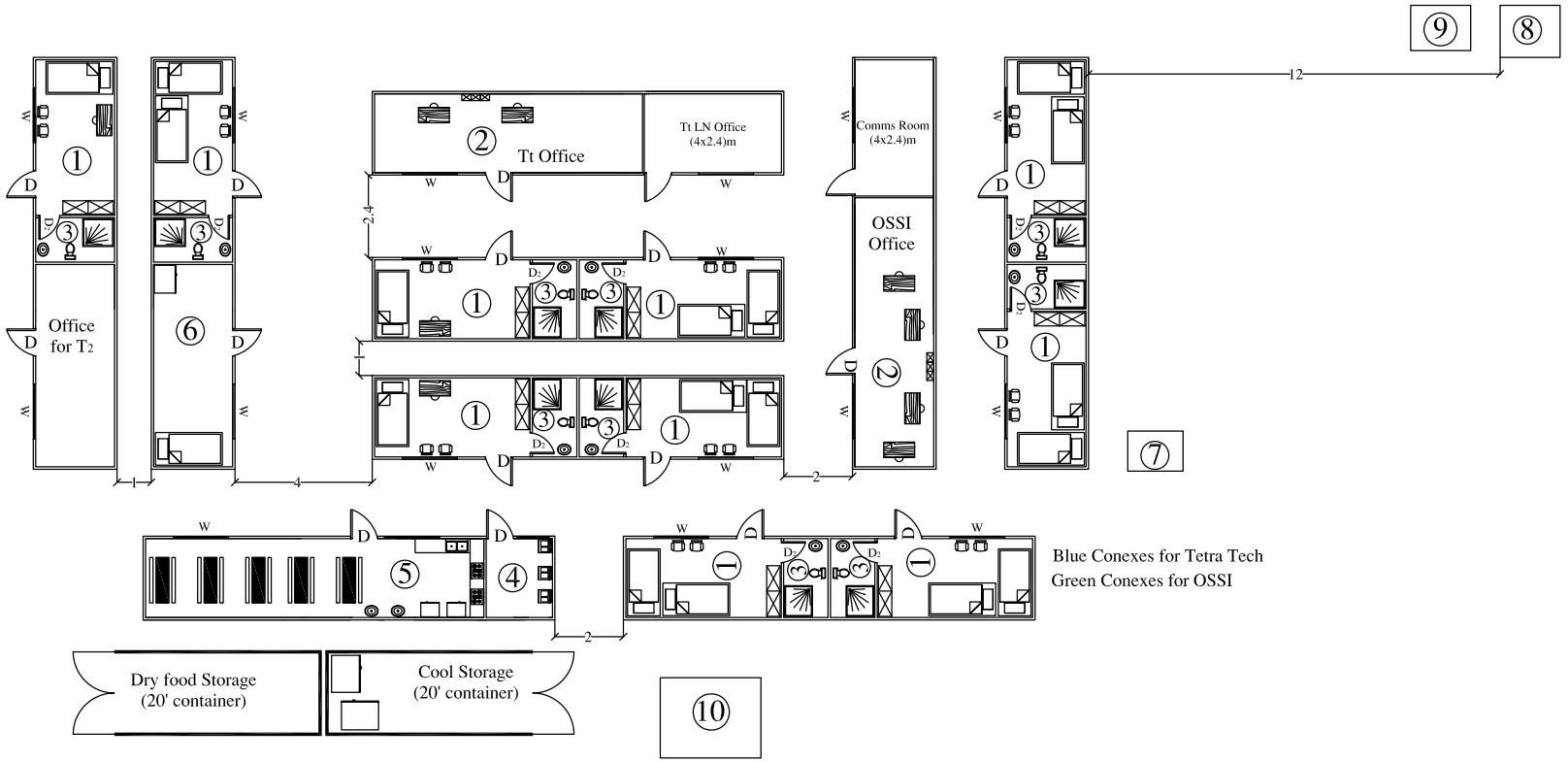
Reachback Direct Labor:	**Adjusted Hr. Rate**	**Hours**	**Subtotal**
PMO - Construction Services	---	---	
Vice President	[redacted]		
Construction Manager 1 - Senior			
Construction Manager 2 - Senior			
Construction Manager 3 - Senior			
Construction Manager			
Construction Technician 1			
Construction Technician 2			
Admin Support			
Subtotal: PMO - Constr			

Expatriate Direct Labor:	**Adjusted. Hr. Rate**	**Hazard Pay Rate (170%)**	**Hours**	**Sub total**
Project Manager	[redacted]			
Quality Control Manager				
Concstruction Manager				
Construction Superintendent				
Trades Expert 1				
Trades Expert 2				
Trades Expert 3				
Subtotal:				

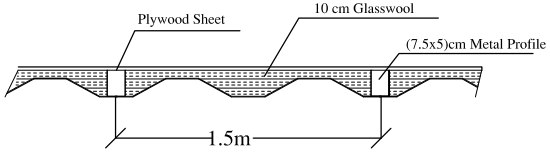
Other Onsite Labor:	Monthly Rate	Months	Sub total
TCN 1	[redacted]		
TCN 2			
TCN 3			
TCN 4			
LCN 1			
LCN 2			
LCN 3			
Subtotal: Ot			

Other Direct Costs:		Assumptions
Operations		
Kandahar Office and Staffer		
Kandahar Staffer Vehicle		
Computers/Printers/Air Card (12)		
Satellite Phone & Internet Service		
Travel		
Visa, permits, fees, etc.		
Airfare for Expatriates (Round trips)		RT every 3 months (2 weeks off) + 6 trips for PMO
Airfare for TCN's (Round trips)		RT every 3 months (2 weeks off)
Shipping and occasional travel by Helio		1 Trip/week
Other		
H&S		
Misc. onsite office facilities		operations facilities not included in LSA
Subtotal: Ot		

[redacted]



Uruzgan Tetra Tech LSA			
Symbol	Name for the room	Total Area (m²)	Description
1	Living Room	4.5x2.4	
2	Office	12.0x2.4	
3	Shower and Toilet	2.4x1.3	
4	Laundry	2.4x2.0	
5	DFAC	10.0x2.4	
6	Medical Facility	6.0x2.4	
7	Water Tank (15000 lit)	πR^2=3.14x1.1²	The length is 4m
8	Generator Pad	3.2x2.2	
9	Fuel Tank (15000 lit)	πR^2=3.14x1.1²	The length is 5m
10	Septic Tank (60000 lit)	6.0x5.0	The depth is 2m
D	Bedrooms' doors	2.0x0.9	Made of PVC
D_2	Bathrooms' doors	2.0x0.8	Made of PVC
D_1	WC doors	2.0x0.65	Made of PVC
W	Window	1.6x0.65	Made of PVC
W_1	Window	0.9x0.65	Made of PVC



All walls and ceilings have the same Section

Tetra Tech LSA in Uruzgan	
Drawn by:	[redacted]
Checked by:	
Date:	28-Oct-2009